



Western Europe: US Coal as an Alternative to Soviet Gas

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An Intelligence Assessment

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An Intelligence Assessment

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[redacted]

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**Western Europe: US Coal
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Key Judgments

*Information available
as of 15 September 1982
was used in this report.*

US coal is one alternative for reducing or supplanting West European purchases of Soviet natural gas. We believe that there is little prospect for expanding West European coal use during the 1980s. Indeed, our analysis indicates that West European coal consumption in 1990 may fall short of planned levels by as much as 950,000 barrels per day oil equivalent (b/doe).

Beyond 1990, however, considerable potential exists for expanding coal use in Western Europe. As growth in nuclear power slows and electricity demand picks up, much of the burden for generating electricity will fall on coal. In the industrial sector, the bulk of existing oil- and gas-fired boilers will need replacing. If West European governments help industrialists overcome the considerable capital costs of switching, we believe coal could capture much of this market—saving an estimated 1.8 million b/doe of oil and gas by 2000. Combined with North Sea and Dutch gas supplies, expanded coal use could obviate the need for additional purchases of Soviet gas in the 1990s. Soviet gas imports by the end of the decade, therefore, could be limited to the 900,000 b/doe already under contract.

Increased coal use will not only enhance the energy security of Western Europe but also improve prospects for US coal exports. West European plans to diversify sources of coal supplies will probably give the United States roughly a one-third share of the coal export market over the next two decades. At current prices, sales of US coal to Western Europe could amount to roughly \$3 billion in 1990 and \$4.5 to \$7 billion by 2000, compared with sales of \$1.9 billion in 1980.¹

To achieve maximum export levels, however, the United States will have to expand port capacity and dredge channels. Such measures would enhance the security of coal as an energy alternative and help restrain increases in coal prices. As the “swing” supplier in the coal market, the United States could capture a considerably higher share of the export market, depending on foreign coal supply disruptions. For example, US coal shipments to the European Economic Community have increased by some 275,000 b/doe over the last two years, largely from filling Polish shortfalls.

¹ Estimates based on current FOB coal prices at US ports.

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Western Europe: US Coal as an Alternative to Soviet Gas

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Energy Security

According to industry estimates, Western Europe's dependence on imported natural gas will increase sharply over the next two decades. Even with slow growth in West European gas demand, depletion of domestic gas supplies² will result in an import dependence growth from less than 15 percent currently to about 50 percent by the turn of the century. If the Siberian pipeline proceeds as planned, continental Europe will be dependent on the USSR for 25 to 30 percent of its total 1990 gas requirements. Beyond 1990, West European gas needs will probably continue to rise, possibly necessitating additional supplies of as much as 1.2 to 1.3 million b/doe from the Soviet Union or elsewhere. This growing level of gas imports will significantly increase Western Europe's vulnerability to disruptions in natural gas supplies.

West European governments also plan to increase imports of coal substantially over the next two decades. Unlike gas, coal imports pose little security risk because demand on the international coal market is currently constrained and is unlikely to exceed export capability for the future. Abundant supplies are available from the United States, Canada, Australia, South Africa, and later from Colombia. Moreover, coal shipments from Poland are reemerging and the Polish Government is likely to foster a steady flow of exports to maintain a foothold in its traditional West European markets to earn hard currency.

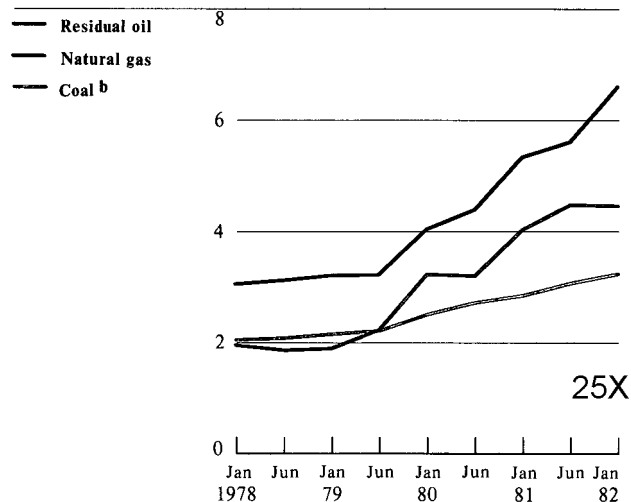
Coal Plans and Outlook Through 1990

Plans for increased coal use have closely followed the oil-price hikes of 1979-80. Although there was heightened interest in coal after the first oil-price shock in 1973-74, the price of oil relative to coal did not rise enough to cause major fuel substitution during the

² Includes Norwegian and Dutch gas.

Figure 1
Western Europe: Industrial Energy Prices^a

US \$ per million BTU



^a Average prices weighted by industrial consumption in UK, West Germany, and France.

^b Coal prices exclude metallurgical coal and are a composite of high-cost domestic coal and imported steam coal.

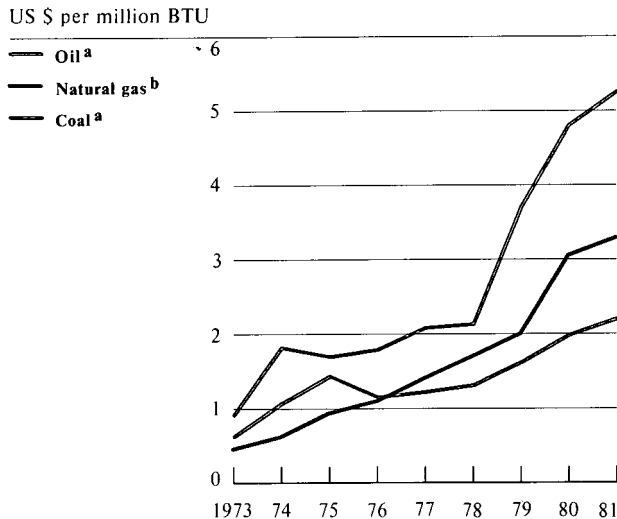
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1970s. Only in 1980 did coal become substantially cheaper than oil for industrial users (figure 1). In the 1980s, unlike the previous decade, we expect a sharp increase in coal use spurred by the large differential between coal and oil and gas prices. In 1981 steam coal could be delivered to Western Europe at about 45 percent of the price of Middle Eastern oil and at half the price of Soviet natural gas (figure 2). Although declining oil prices this year have lessened coal's price advantage, a substantial differential is expected to be maintained during the 1980s.

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Figure 2
Western Europe: Energy Import Prices

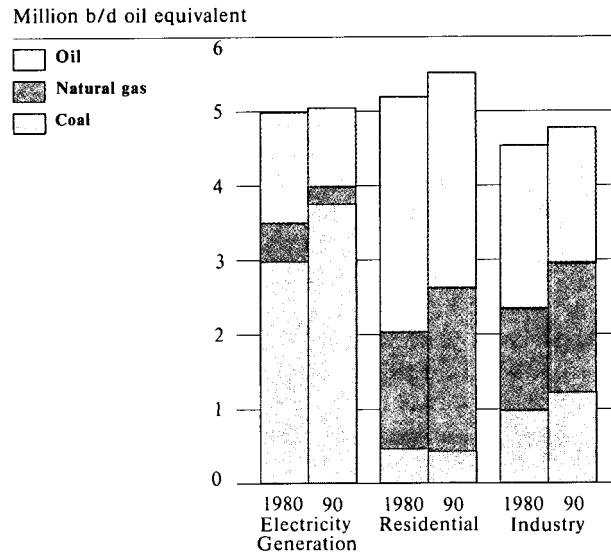


^a Heavy fuel oil (one percent sulfur) and steam coal CIF to Rotterdam.

^b Weighted average of Netherlands gas exports to Belgium, France, West Germany, and Italy. Price at Dutch border.

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Figure 3
Western Europe^a: Sectoral Fuel Consumption^b



^a OECD Western Europe excluding Portugal and Turkey.

^b Excludes fuel used in the transport and energy transformation sectors.

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According to the latest government forecasts, Western Europe's coal requirements in 1990 are projected to reach 7.4 million b/doe—up 2.4 million b/doe over consumption last year.³ We believe coal demand in Western Europe will grow substantially, but growth will be less rapid than these official projections indicate. According to projections by US oil companies and consulting firms, for example, demand will total 6.6 million b/doe by 1990—800,000 b/doe below government projections. Several factors account for this lower demand forecast:

- Low prospects for economic growth and high interest rates, both of which affect investment in new coal-fired plant and equipment.
- Lowered projections of electricity demand.
- Soft oil prices and rising coal prices, which have lessened coal's economic advantage and created uncertainty over the future evolution of coal prices.
- Continuing concern about the environmental impact of using coal and the costs of complying with environmental standards.

³ One million b/d oil equivalent is equal to 74 million tons of coal equivalent (MTCE).

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Our assessment is that Western Europe's coal use will approximate 6.5 million b/doe by 1990, compared with about 5 million b/doe in 1981. This evaluation is based on our review of the most recent private-sector forecasts as well as on our own analysis of key coal-use sectors.

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Sectoral Demand

Electric Utilities. Electric utilities will add the largest increment to coal demand during the 1980s, accounting for about three-fourths of the increase. Low levels of electricity demand, however, have slowed the construction of new coal-fired plants and soft oil prices are likely to halt the conversion of some existing facilities to coal. More than 50 percent of the additions to coal-fired capacity anticipated by 1990, for example, will probably not be realized because construction is not yet under way and leadtimes average six to eight years.

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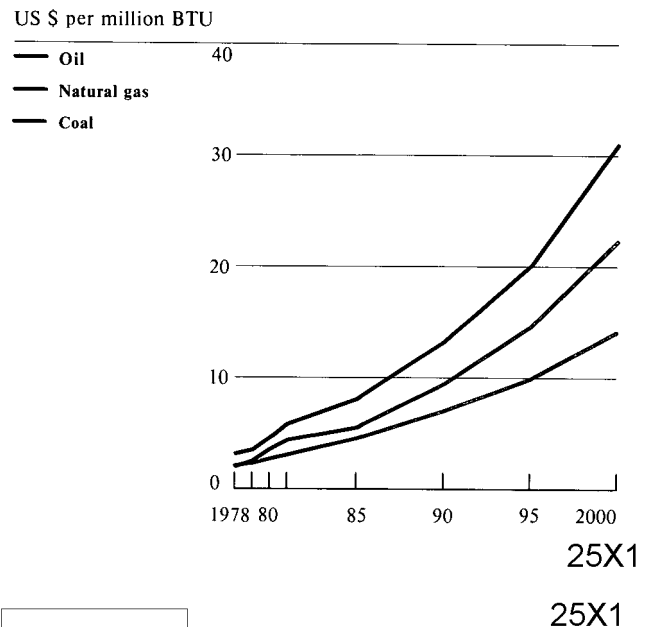
Industrial. According to industry sources, industrial coal use will increase by some 200,000 b/doe during the 1980s. Much of this increase will come from conversion to coal in the cement industry. Coal use in industrial boilers—the largest industrial consumer of energy—will grow slowly. Industry is locked into an existing capital stock of oil- and gas-fired boilers, most of which do not need replacing for several years. Moreover, the high capital costs of coal boilers will probably preclude the early retirement of existing boilers. Coal is likely to make inroads only where boilers are needed at new sites and when boilers outlive their usefulness, primarily in the late 1980s and early 1990s. Other constraints slowing the move to coal in industry are:

- Lack of coal storage facilities.
- Inadequate coal distribution infrastructure.
- Lack of ash disposal sites.
- Environmental restrictions.

Other Sectors. Coal use in the residential sector will continue to decline. Gas is still the cheapest means of home heating, and the capital intensive nature of coal-fired district heating systems largely limits their use to Scandinavian countries. Coal demand for synthetic fuels production is expected to be small through the 1980s according to both government and private-sector forecasts. Rising project costs, the high cost of coal feedstocks in Europe, and uncertain profitability in view of the soft oil market have delayed coal gasification and liquefaction projects.

During the 1980s, coal-based synfuels are likely to be limited to situations where the costs are low because the fuel is produced in conjunction with a related industrial process. For example, in the steel industry, a higher quality synthetic gas can be produced through a molten iron gasification process. In West Germany, the leading European developer of synfuels, the government continues to give liquefaction and gasification a high priority in research funding, mainly to develop export sales. According to recent State Department reporting, only two gasification demonstration projects are likely to receive continuing government support; a third is proceeding as a commercial venture. However, a study by the Institute for Gas Technology (IGT) concludes that the total contribution to 1990 German energy supplies will probably not exceed 60,000 b/doe from all synfuels projects

Figure 4
Western Europe: Projected Industrial Energy Prices



including those producing low- and medium-BTU gas. Despite open-source reporting that CDF (the French Coal Company) will produce synthetic natural gas with an energy equivalent of 66,000 b/doe by 1990, we estimate, based on the IGT study, that France will produce only one-sixth that level.

Prospects Beyond 1990

Beyond 1990, considerable potential exists for further expansion in coal use in Western Europe. Projected fuel price trends favor coal. Recent private-sector forecasts indicate upward pressure on oil prices after the mid-1980s, and, given the present linkage between oil and gas, gas prices are likely to increase. Although coal prices will also trend upward, they are unlikely to keep pace with alternative fuels. We expect coal to maintain or improve on its already substantial price advantage over competing fuels (figure 4).

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Confidential**Table 1**
Western Europe: Coal Requirements*Thousand b/doe*

	1973	1979	1981	1990 ^a
Total	4,827	4,889	4,979	6,450
West Germany	1,600	1,546	1,650	1,950
United Kingdom	1,525	1,448	1,320	1,400
France	556	613	559	590
Spain	171	219	329	460
Belgium	222	219	216	230
Italy	207	229	268	460
Denmark	39	84	108	190
Netherlands	85	64	79	195
Greece	94	80	78	145
Austria	72	62	62	95
Turkey	92	131	157	385
Other	164	194	153	350

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Table 2
Western Europe: Forecasts of Coal Demand ^a*Million b/doe*

	Forecast Date	Coal Demand	
		1990	2000
Data Resources	May 1982	6.5	9.3
OECD/World Energy Outlook	April 1982	7.3-7.7	11.4
IEA/Country Review ^b	February 1982	7.4	
Exxon	February 1982	7.0	8.5
Chevron	June 1982	6.2	7.9
Shell	January 1982	6.8	8.9

^a Countries included in these projections vary slightly among forecasters.^b Data are for 16 West European members of the IEA plus France and Finland.

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Western Europe: Energy Prices

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Analysis of key fuel markets suggests that relative energy prices in Western Europe will remain fairly stable over the next two decades.

Most long-term energy projections by industry assume flat or declining real oil prices through the mid-1980s. Oil prices are projected to rise by 2 to 3 percent per year in real terms from 1985-2000. As market conditions tighten, other energy prices are also assumed to increase.

We expect coal prices to rise but remain competitive with oil. [redacted] for example, coal will have about a 20-percent price advantage over oil in 1990 even after including the extra cost of building coal-fired power plants. The large resource base for coal, considerable scope for expanded production, and a diverse set of competing suppliers will all tend to restrain real increases in coal prices.

We expect gas prices will continue to increase sharply over the next two decades. Cheap indigenous supplies are dwindling and new gas reserves—those in the North Sea, for example—will be costly to develop. Moreover, there is increasing linkage between oil and gas prices in new contracts.

Sensitivity of Coal Demand

As a substitute for oil, coal demand is responsive to changes in oil prices. We believe, however, that further moderate declines in oil prices will probably have little effect on coal demand. The bulk of

increased coal use during the 1980s will come from electric utilities where coal requirements are a function not only of relative fuel prices but also of government policy to reduce oil use. Moreover, coal currently enjoys a substantial price advantage over oil in the utility sector, and oil prices would have to fall significantly before having a major effect.

In existing facilities, for example, coal requires only about a \$.20 per million BTU price advantage over oil to offset the added handling costs associated with burning coal. As a result, oil prices would have to fall by roughly 35 percent before existing coal-fired facilities would consider a switch to oil. When considering the installation of new coal-fired capacity, coal requires about a \$.75 per million BTU price advantage over oil to offset both higher capital and handling costs of coal-fired equipment. The price of oil would thus have to fall about 10 to 15 percent below current levels to make industry reconsider the installation of new coal-fired boilers. For European power stations, which rely heavily on cheaper imported coal, the price of fuel oil would have to fall about 30 percent before utilities reconsidered coal plans.

Lowered projections of electricity demand have probably had a larger effect on future coal requirements than declining oil prices. [redacted]

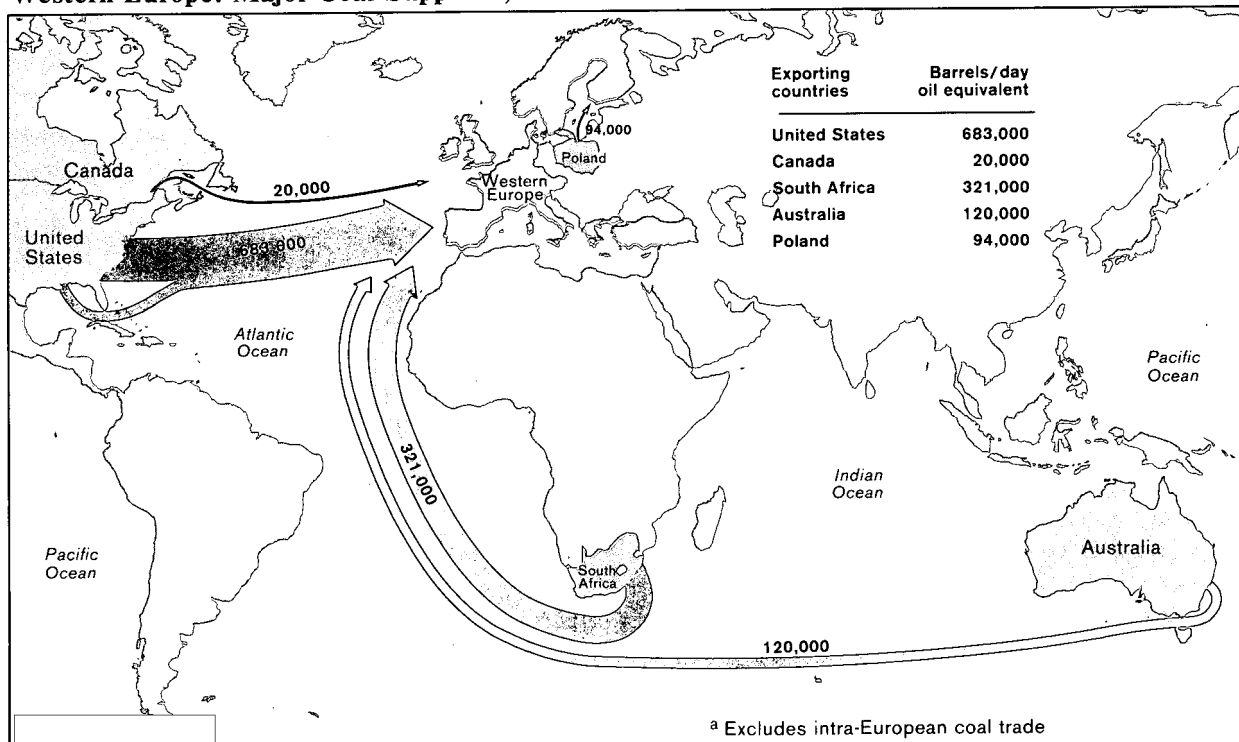
[redacted] for example, a 1-percent change in total electricity generation affects West European coal requirements by about 100,000 b/doe.

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Figure 5
Western Europe: Major Coal Suppliers, 1981^a



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Aside from coal's price advantage, an expected slow-down in the growth of nuclear power will place added requirements on coal for electricity generation. Based on the most recent country projections for the 1990s, nuclear power capacity is expected to grow at less than half the rate of the 1980s. Concern over nuclear wastes and perceived accident risks have lessened public and political confidence in nuclear power. Moreover, the long leadtimes for licensing and constructing plants and the high capital costs and interest rates are likely to continue.

Shortfalls in nuclear power will probably be met by coal. Most countries have policies that generally prohibit new oil-fired capacity, and some countries also prohibit new gas-fired capacity. Coal-fired plant construction programs that were delayed during the 1980s because of sluggish electricity demand will probably be completed in the 1990s along with major

expansions. When the projects are completed, West European governments will probably trim oil and gas use in electric utilities, perhaps to less than 4 percent of projected electricity generation.

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The greatest potential for increased coal use exists in industry. The industrial sector consumes nearly twice as much oil and gas as electric utilities. By the early 1990s, life will end for many of the oil and gas-fired boilers installed in the late 1960s and early 1970s. If governments help offset the large capital costs of switching to coal through subsidies, tax incentives, and low interest loans, industrial coal use could reach 3.6 million b/doe by the year 2000, about 1.8 million b/doe above most current projections.

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The Coal-Gas Trade-Off

According to industry estimates, nearly 40 percent of the increase in Western Europe's gas use over the next two decades is expected in the industrial sector. We believe increased use of coal could probably supplant about one-fourth of projected industrial gas demand by the year 2000. Higher industrial coal use, coupled with additional gas supplies from Norway and the Netherlands—for the residential sector, where coal use is severely restricted—could obviate the need for additional purchases of Soviet gas in the 1990s.

If industrial coal demand is to reach its potential in the next decade, however, some actions must be taken. These would include:

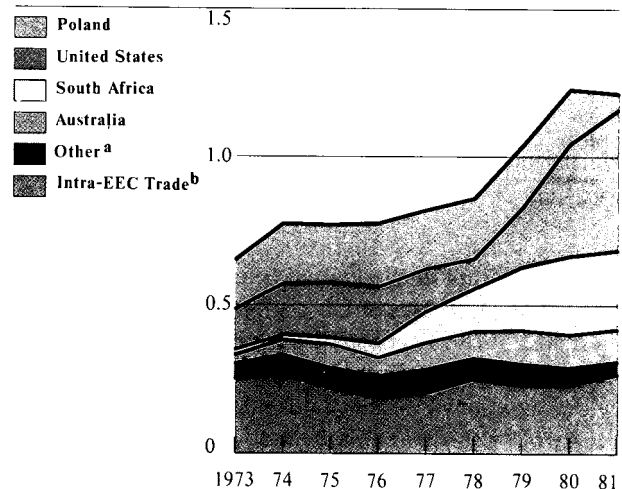
- Development of the infrastructure system, including ports, railways, depots, and ash disposal systems, essential to industrial coal use.
- Development of coal ports in the major exporting countries.
- Dissemination of information and demonstration projects on the conversion from oil and gas to coal.
- Adoption of financial incentives or other measures to stimulate conversion to coal.
- The removal of overly stringent environmental or other constraints on coal use.
- Continued development of more efficient and environmentally clean technologies in the areas of combustion, coal handling, and coal conversion.

Potential for US Coal Exports

US coal shipments to Western Europe have increased sharply in recent years—jumping from some 260,000 b/doe in 1979 to 670,000 b/doe in 1981 (figure 7). Future US coal exports will largely be in response to countries' plans to diversify suppliers and their perceptions of supplier reliability. Supply disruptions caused by strikes in Australia and Poland over the last two years have heightened the awareness of the need to diversify. By filling previous shortfalls, the United States has gained a strong foothold in the European steam coal market; in 1981, for example, the United States supplied nearly a third of the steam coal imported by Western Europe, up from less than 3 percent in 1979 (table 3).

Figure 6
European Economic Community: Coal Imports by Supplier

Million b/d oil equivalent



^a Largely USSR and Canada.

^b Largely UK and West Germany.

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Although the US market share may eventually decline with the reemergence of shipments from Poland and the increase in exports from South Africa in the mid-1980s, recent market studies by the National Coal Association, ICF Inc., and an international coal company estimate a 26- to 30-percent share of the West European steam coal market for the United States over the next decade. We believe the United States will capture roughly a third of the West European coal import market including metallurgical coal—historically the mainstay of the US-European coal trade. Thus, US coal exports will probably reach nearly 800,000 b/doe in 1990.

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We believe US coal shipments could range between 1.2 and 1.8 million b/doe by the year 2000, depending upon the development of industrial coal demand. Being the swing supplier in the market could help the United States capture a substantially higher share of West European coal purchases, especially if coal supplies from other countries are disrupted.

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Table 3
Western Europe: Coal

	Imports (million b/doe)			US Share (percent)		
	1979	1980	1981	1979	1980	1981
Total	1.30	1.49	1.52	20	32	44
Steam	.76	.89	.97	3	18	32
Metallurgical	.54	.60	.55	45	52	65

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Several factors in the United States could restrict European purchases of US coal, according to the Coal Director of the European Economic Community. US coal sampling methods are a factor. The resulting wide variations in coal quality have caused problems with power station equipment and made compliance with air quality standards difficult. Cost of transport is another factor. The continued sharp increases in rail transport rates could rob US coal exporters of their competitive advantage in ocean transport. The US Congress is currently considering cargo preference legislation that would require 40 percent of the trade volume be shipped in American flag vessels. Europeans fear that such a requirement would not only create administrative hurdles but also price US coal out of the market because of the higher rates charged by US shippers. [redacted]

In the longer term, the inability of US ports to accommodate vessels of 100,000 deadweight tons (dwt) could be the most severe restriction on US coal

shipments to Western Europe.⁴ With ocean freight rates accounting for between 15 and 30 percent of the delivered price of steam coal, large colliers of 100,000 dwt to 150,000 dwt will probably become the predominant vessels. Currently, all major foreign coal-exporting countries as well as Japan and the importing countries of Western Europe have at least one coal terminal that can accommodate vessels of 100,000 dwt and up, and more are planned. By the year 2000, the larger ships will carry a significant portion of the coal, most of which will not stop at US ports unless deeper channels are dredged or alternate coal loading technologies are developed.⁵ [redacted]

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⁴ Hampton Roads can accommodate vessels of approximately 100,000 dwt, but only under special tidal conditions. Normally, the port is limited to 80,000 dwt colliers. [redacted]

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⁵ Some economic alternatives to port dredging are vessel-to-ship loading arrangements, such as, small ships, barges, and floating terminals topping off large colliers. [redacted]

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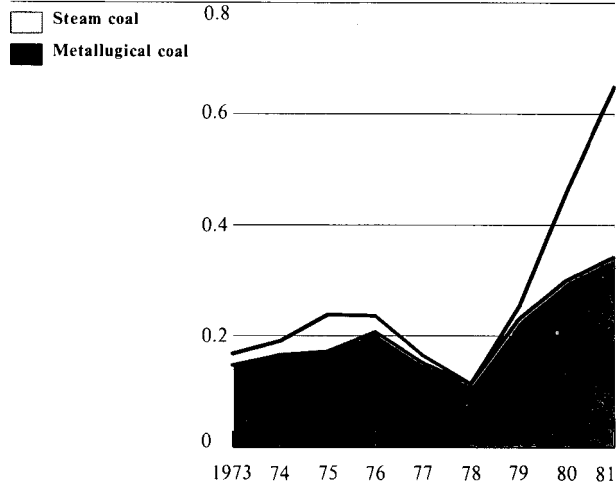
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Figure 7
Western Europe: US Coal Imports

Million b/d oil equivalent



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Table 4
Western Europe:
Spot Steam Coal Prices, 1981

US \$ per million BTU

Exporter	FOB (Coast)	Ocean Freight	Delivered
Australia	\$1.97	\$.82	\$2.79
Canada	1.83	.71	2.54
Poland	2.11	.33	2.44
South Africa	1.67	.44	2.11
United States	1.97	.52	2.49

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Table 5
Sizes of Ships Used
in Transporting Coal

Deadweight tons and percent

Ship Size	Seaborne Coal Trade		
	1970	1975	1980
Under 60,000	90	66	49
60-100,000	10	24	25
Over 100,000		10	26

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Coal Demand Close Up

West Germany. Opposition to nuclear power and the relaxation of coal import quotas have paved the way for increased coal use. Because imported steam coal currently costs about \$67 per ton c.i.f. at West German ports and domestic coal runs above \$110 per ton, lowered barriers on imported coal provide ample financial incentive to plan coal-fired power plants. State Department reporting indicates that West Germany is expected to make the largest additions to coal-fired electric generating capacity in the European Economic Community during the 1980s, increasing coal-fired capacity by some 10,000 MW. Considerable problems of coal access and storage will severely limit industrial coal use. Natural gas is expected to experience the most dynamic demand growth in the industrial sector, increasing by some 100,000 b/doe during the decade according to industry projections.

United Kingdom. We believe coal use in electricity generation will decline during the 1980s. Additions of nuclear power and oil-fired plants are planned, and several aging coal-fired units—totaling 7,400 MW—are slated for retirement. Increased industrial coal use, however, should raise overall coal consumption albeit slightly. The National Coal Board is currently handling almost 1,000 inquiries from industrialists considering a switch from oil to coal. The scope for oil to coal conversion is considerable given that 40 percent of the 15,000 steam-raising units are more than 20 years old. Problems of coal access and storage, however, will probably impede the substitution process relative to its potential. Moreover, pressure on the government by domestic coal producers

for implementation of quotas on cheap imported coal, we believe, will lessen coal's competitive edge over oil products.

France. We believe coal consumption will increase slightly above current levels by 1990. An aggressive nuclear program will continue to cut into coal consumption for electricity generation, but Paris expects increased industrial coal use to pick up the slack. Although there is yet no significant shift to coal in industry with the exception of cement, Paris has provided numerous incentives that should assure that industrial coal usage increases roughly in line with plans.

Italy. According to Italian officials of AGIP Carbone, the state coal firm, and Italsider, the state steel firm, steam coal consumption in 1990 will reach about 300,000 b/doe—240,000 b/doe below the estimate of the National Energy Plan. Plans to convert existing oil-fired power plants to coal will probably proceed but only two new plants are likely to be in operation by 1990, rather than the three to five under discussion. Reasons for the slowdown in the construction of new coal-fired plants, officials contend, are: lower-than-expected growth in electricity demand, greater use of existing capacity, availability of electricity imports from France, and problems in siting new plants. Moreover, soft oil prices are a disincentive for industries to convert to coal.

Netherlands. Because of strong opposition to nuclear power, much of the burden of diversifying Dutch energy sources away from oil and gas has fallen to

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coal. A program is currently being outlined to convert 2,000 MW of existing oil- and gas-fired electric generating capacity to coal. Construction of new coal-fired plants, however, has been delayed until the late 1980s because of over-capacity in thermal power generation. Industrial use of coal will increase: the rate of penetration will be limited because a large share of industrial fuel consumption is used for producing feedstocks.

***Belgium.** Stagnant electricity demand over the last two years has resulted in a downward revision of growth forecasts by the government. Only one new coal-fired power plant is planned for the 1980s. Moreover, declining oil prices are likely to delay the conversion of some existing oil-fired plants to coal. In industry, the high capital cost of conversions to coal and the physical problems of access and storage of coal will impede coal's penetration in this market.*

***Denmark** leads in converting oil-fired power plants to coal: coal use for electricity generation exceeded 80 percent last year, up from only 20 percent in 1973. With further conversions planned and all future baseload electricity plants to be coal-fired, coal consumption will continue to rise, albeit at a more moderate pace.*

***Spain** is relying primarily on coal in the near term to reduce its heavy dependence on oil until the nuclear program gets under way. According to market studies, demand for coal is expected to surge through*

1985 because of increased coal use by electric utilities and the cement industry. Thereafter, growth should slow unless the nuclear program falls substantially behind schedule.

***Greece.** Plans for the construction of two 350-MW power stations using imported steam coal were dropped from the revised national energy plan last year. Domestic lignite is to be the primary fuel for electricity generation. Only private industry—primarily cement—is switching to steam coal, all of which must be imported.*

***Sweden.** Environmental concerns will result in a cautious approach to coal. Coal consumption in 1990 is expected to be about half of estimated potential, according to government estimates. Steam coal will be used mainly in industry and in hot water plants for district heating.*

***Ireland.** The bulk of new baseload electricity generation will be coal fired. A 900-MW coal-fired plant is currently under construction at Moneypoint, of which 600 MW are expected to be in service by 1986. In addition, the cement, sugar, and dairy industries are converting to coal.*

***Austria.** Environmental objections will delay the construction of coal-fired power plants. High transport costs for coal because of Austria's landlocked position will probably hamper industrial coal use.*

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Sectoral Fuel Use and Substitution Potential

Coal can be directly substituted for gas in only limited circumstances—primarily in large industrial and utility boilers. In electric utilities, coal is expected to back out about 280,000 b/doe of gas during the 1980s, according to industry projections. Gas consumption, however, will increase in both the residential and industrial sectors where coal use is currently constrained by physical and economic factors.

Electricity Generation

Electric utilities are the major market for coal. Coal has a substantial economic advantage over oil and gas for electricity generation and is the primary fuel for new thermal power plants. Gas consumption by electric utilities will continue to decline; West European governments are pursuing policies to trim gas use to less than 5 percent of fuel for electricity generation by 1990. West German utility gas consumption, for example, the largest in Europe, is projected to fall by about 100,000 b/doe by 1990,

[redacted] Beyond 1990 we believe the decline in gas consumption will slow, and gas use will probably stabilize at around 190,000 b/doe by the year 2000—representing some 3 percent of fuel for electricity generation.

Residential

Residential heating demand will be the fastest growing market for gas. According to industry estimates, about 60 percent of the increase in Western Europe's gas use over the next decade is expected to be in the residential sector. Coal is unlikely to be directly substituted for gas in any significant quantity. In the longer term, increased use of electricity produced from coal is an option for replacing gas with coal in the residential sector.^a

^a No specific estimate of expanded coal use in electricity generation was made for the 1990s. For example, however, 1 million b/doe of additional coal, which would require about 55 new 700-MW units, could replace approximately 500,000 b/doe in residential gas consumption. [redacted]

[redacted]

Industry

Consumption of both coal and natural gas will increase in the industrial sector during the 1980s, according to all government and private-sector forecasts. Most industry analysts believe growth in coal use will be slow, however, its rate of penetration will be impeded by the physical restrictions of coal access, storage, and handling and by the high capital costs of converting or installing new coal-burning equipment. New coal boilers, for example, are between one and a half and three times as expensive as oil or gas boilers. The ancillary equipment required for coal—storage, handling, and preparation equipment—is also considerably more expensive. Taken together, capital costs are generally two to four times as much for coal. Nonfuel operating costs are also higher; coal requires additional handling equipment and boilers need more servicing. Electricity consumption for conveyors, handling, and stoking equipment also increases operating costs.

In balancing the higher capital and nonfuel operating costs of coal-fired equipment against reduced fuel costs, industrialists are likely to opt for a coal boiler over an oil- or gas-fired boiler at a new site or when replacing worn-out boilers. The economics of replacing existing oil- and gas-fired boilers with coal, however, are not as favorable with payback periods far in excess of two years. As a result, with boiler stocks in Western Europe dominated by relatively new oil- and gas-fired boilers, growth in coal use will probably be slow during the 1980s.

According to industry projections, gas use in the industrial sector is expected to increase by about 370,000 b/doe by 1990, accounting for roughly 40 percent of the increase in Western Europe's gas requirements during the 1980s. Although all industry analysts believe gas will be significantly more expensive than coal, it has several nonprice advantages: the use of gas largely avoids the difficulties of fuel

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**Comparative Economics of Coal- and
Oil-Fired Boilers ^a**

	Coal (Thousand) dollars per year)	Oil	Cost of Coal Over Oil
Total costs	1,248	1,465	85
Capital charges	158	72	219
Fuel costs	916	1,297	71
Operating costs	174	96	181

^a Assumes a steam-raising plant capable of producing 60,000 pounds of steam per hour operating at 75 percent of capacity for 4,000 hours in the year. Cost of capital is 10 percent per annum.

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access, storage, and handling associated with coal use. Moreover, natural gas is a clean burning and controllable fuel.

Beyond 1990, coal use could expand substantially in the industrial sector. With many oil- and gas-fired boilers due for replacement and government incentives to overcome the high capital costs of switching, industrial coal demand could reach 3.6 million b/doe by the year 2000—1.8 million b/doe above current projections. We believe coal will largely displace oil since oil boilers are greater in number and older than most gas boilers. Moreover, nearly 20 percent of industrial gas requirements are used for feedstocks in the chemical industry where coal is not directly substitutable. On the other hand, the higher price of gas compared with oil in many countries will likely spur industrialists to switch from gas to coal where technically feasible. Altogether, we believe about 450,000 b/doe of gas can be backed out of the industrial sector through expanded coal use by the year 2000.

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